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EXAMINER	
COX, ALEXIS K	

ART UNIT	PAPER NUMBER
3744	

MAIL DATE	DELIVERY MODE
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/578,462	LIU ET AL.	
	Examiner	Art Unit	
	ALEXIS K. COX	3744	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE _3_ MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) _1-15_ is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) _1-15_ is/are rejected.

7)☒ Claim(s) _7-15_ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on _08 May 2006_ is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application

6) ☐ Other: _____.

DETAILED ACTION

Claim Objections

1. Claims 3, 4, and 6 are objected to because of the following informalities: the limitation "a first constant S1" on line 7 of claim 3 should be changed to "by a first constant S1" to make it logically consistent. The limitation “a fourth constant” on line 23 of claim 3 should be changed to “by a fourth constant” to make it logically consistent. Appropriate correction is required. The term “it” on line 2 of claim 6 should be changed to “the air conditioning unit” for increased clarity.

2. Claims 7-15 are objected to under 37 CFR 1.75 (c) as being in improper forms because a multiple dependent claim cannot depend from any other multiple dependent claim. See MPEP § 608.01(n).

Claim Rejections - 35 USC § 112

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claims 1-15 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Regarding claim 1, it is unclear whether the density of the refrigerant and the pressure of the refrigerant at the inlet of the expander are to be estimated, measured, or calculated.

Regarding claim 5, it is unclear what the calculating function is specific to, as it cannot simultaneously be “specific to calculating the density of the refrigerant from the

refrigerant temperature at the inlet of the expander and from the refrigerant pressure at the inlet of the expander" (lines 3-6 of claim 5) and "using ... the density of the refrigerant ... to calculate an estimate of the refrigerant mass flow rate at the expander" (lines 12-17 of claim 1), because the term "specific to" specifies the end product of the calculation to be the density of the refrigerant, not the refrigerant mass flow rate.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

6. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

7. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to

consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

8. Claims 1, 2, 5, and 6 are rejected under 35 U.S.C. 103 (a) as being unpatentable over Alsenz (US Patent No. 5,402,652) in view of Thermodynamics: an engineering approach (Cengel and Boles, international edition 2004).

Regarding claims 1 and 2, Alsenz discloses a refrigeration system comprising a compressor (30, see column 4 line 64), a condenser (34, see column 4 line 64), an expansion device (38, see column 4 line 65), an evaporator (44, see column 4 line 65), and an electronic controller (200, see column 8 line 34) designed to interact with the refrigeration circuit. It is noted that the system of Alsenz is not characterized in that the electronic control device includes a calculating function using an estimate of the flow area of the expander, the density of the refrigerant and the pressure of the refrigerant at the inlet of the expander in order to calculate an estimate of the refrigerant mass flow rate at the expander. However, the controller of Alsenz is capable of performing such a calculation (see column 16 lines 36-38). Further, it falls within the realm of common knowledge to calculate mass flow rate using flow area, density, and pressure, as can be seen from pages 6, 32, and 142 of Cengel and Boles. Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to program the controller of Alsenz to calculate the mass flow rate of the refrigerant using an estimate of the flow area of the expander, the density of the refrigerant and the pressure of the refrigerant at the inlet of the expander in order to have better monitoring of the system of Alsenz.

Regarding claim 5, it is noted that the controller of Alsenz is not explicitly stated to calculate the density of the refrigerant at the inlet of the expander from the temperature and pressure at the expander inlet. However, it falls within the realm of common knowledge to use the ideal gas law to calculate the density of a gas from temperature and pressure, and therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to do so in order to avoid storing refrigerant-specific density tables for mass flow calculations.

Regarding claim 6, Alsenz discloses the presence of a probe placed at the inlet of the expander for measuring the refrigerant temperature (70, see column 12 line 25).

9. Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Alsenz (US Patent No. 5,402,652) in view Thermodynamics: an engineering approach (Cengel and Boles, international edition 2004), further in view of Gregg et al (US Patent No. 4,977,529).

Regarding claim 3, it is noted that Alsenz does not explicitly disclose the modeling of the valve flow area as a series of linear functions. However, Gregg et al discloses a valve simulation which estimates valve flow area using a series of linear functions (see column 148 lines 43-60). It would therefore have been obvious to one of ordinary skill in the art at the time of the invention to implement the modeling technique of Gregg et al in the system of Alsenz as a mathematically simple but effective backup, to ensure the received data did not indicate a system fault.

10. Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Alsenz (US Patent No. 5,402,652) in view of Thermodynamics: an engineering approach

(Cengel and Boles, international edition 2004), further in view of Gregg et al (US Patent No. 4,977,529), further in view of Ben Yahia (US Patent Application Publication No. 2003/0159452) and the application.

Regarding claim 4, it is noted that the system of Alsenz in view of Cengel and Boles and further in view of Gregg et al does not explicitly disclose the pressures at the expansion valve to be between approximately 80 bar and 135 bar or the areas to be between approximately .07 mm^2 and 3.14 mm^2. However, the supercritical air conditioning cycle of Ben Yahia uses carbon dioxide (see paragraph [0002]), and it would have been obvious to one of ordinary skill in the art to use pressures between approximately 80 bar and approximately 135 bar when modeling a system using carbon dioxide in order to optimize performance. Additionally, as the general concept of optimizing the dimensions of an expansion valve for a particular application following completion of a design falls within the realm of common knowledge, it would have been obvious to one of ordinary skill in the art at the time of the invention to use the pressures of approximately 80 bar, 110 bar, and 135 bar, and the areas of .07 mm^2, .5 mm^2, .78 mm^2, and 3.14 mm^2 in a model of the expansion valve of Alsenz in view of Gregg et al further in view of Ben Yahia et al, in order to use the best balance of accuracy and simplicity possible.

11. Claims 1, 2, 5, and 7-15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Singh et al (US Patent Application Publication No. 2003/0005710) in view of Thermodynamics: an engineering approach (Cengel and Boles, international edition 2004).

Regarding claims 1 and 2, Singh et al discloses an air conditioning unit provided with a supercritical refrigerant circuit (see paragraph [0064]) comprising a compressor (104, see paragraph [0065]), a condenser (126, see paragraph [0064]), an expander (138, see paragraph [0064]) defining a refrigerant flow area, an evaporator (136, see paragraph [0064]), and an electronic control device designed to interact with the refrigerant circuit (140, see paragraph [0065]). It is noted that the system of Singh et al is not characterized in that the electronic control device includes a calculating function using an estimate of the flow area of the expander, the density of the refrigerant and the pressure of the refrigerant at the inlet of the expander in order to calculate an estimate of the refrigerant mass flow rate at the expander. However, the controller of Singh et al is capable of performing such a calculation (see paragraph [0065]). Further, it falls within the realm of common knowledge to calculate mass flow rate using flow area, density, and pressure, as can be seen from pages 6, 32, and 142 of Cengel and Boles. Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to program the controller of Singh et al to calculate the mass flow rate of the refrigerant using an estimate of the flow area of the expander, the density of the refrigerant and the pressure of the refrigerant at the inlet of the expander in order to have better monitoring of the system of Singh et al.

Regarding claim 5, it is noted that the controller of Singh et al is not explicitly stated to calculate the density of the refrigerant at the inlet of the expander from the temperature and pressure at the expander inlet. However, it falls within the realm of common knowledge to use the ideal gas law to calculate the density of a gas from

temperature and pressure, and therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to do so in order to avoid storing refrigerant-specific density tables for mass flow calculations.

Regarding claim 7, Singh et al discloses the presence of a sensor at the inlet of the expander for measuring the refrigerant pressure at the inlet of the expander (130, see paragraph [0126]).

Regarding claim 8, it is noted that the system of Singh et al is not explicitly stated to include a power estimation function capable of estimating the power absorbed by the compressor from the refrigerant mass flow rate provided by the calculating function, the work of the compressor, and the rotation speed of the compressor. However, the controller of Singh et al is capable of doing so (see paragraph [0065]). Additionally, it would have been obvious to one of ordinary skill in the art at the time of the invention to do so in order to minimize power use and ensure the accuracy of power meters in use (see paragraph [0140]).

Regarding claim 9, it is noted that Singh et al does not explicitly state the electronic control device to estimate the work of the compressor form the refrigerant pressure at the inlet of the expander, the refrigerant pressure at the inlet of the compressor and a refrigerant temperature relative to the compressor. However, the electronic control device of Singh et al is capable of doing so (see paragraph [0065]). Further, falls within the realm of common knowledge to calculate the work of a compressor from pressure at the inlet, pressure at the outlet, and an associated refrigerant temperature. It would therefore have been obvious to one of ordinary skill in

the art at the time of the invention to estimate the work of the compressor in this way to ensure a minimum of wear on the compressor.

Regarding claim 10, it is noted that Singh et al does not explicitly state the electronic control device to estimate the refrigerant pressure at the inlet of the compressor from a pressure at the inlet or at the outlet of the evaporator combined with the refrigerant mass flow rate. However, the electronic control device of Singh et al is capable of doing so (see paragraph [0065]). Further, falls within the realm of common knowledge to calculate the refrigerant pressure at the inlet of the compressor form a pressure at the inlet or at the outlet of the evaporator combined with the refrigerant mass flow rate. It would therefore have been obvious to one of ordinary skill in the art at the time of the invention to estimate the refrigerant pressure at the inlet of the compressor from a pressure at the inlet or at the outlet of the evaporator combined with the refrigerant mass flow rate in order to enable calculation of the compressor work without using additional sensors.

Regarding claim 11, Singh et al explicitly discloses the presence of a temperature sensor (128, see paragraph [0064]) measuring a temperature relative to the evaporator (see figure 2) and a temperature sensor measuring the temperature of the space to be cooled (see paragraph [0066]). It is noted that Singh et al does not explicitly disclose the use of a temperature relative to the evaporator, the temperature of the air to be cooled, and the efficiency of the evaporator to calculate the temperature at the inlet or outlet of the evaporator. However, it falls within the realm of common knowledge to use the efficiency of the evaporator as approximated by its manual, the

temperature of the space to be cooled, and a temperature relative to the evaporator to calculate the refrigerant temperature at the inlet or outlet of the evaporator. Further, it would have been obvious to one of ordinary skill in the art at the time of the invention to use the efficiency of the evaporator as approximated by its manual, the temperature of the space to be cooled, and a temperature relative to the evaporator to calculate the refrigerant temperature at the inlet or outlet of the evaporator in order to confirm the accuracy of sensors and efficiency of the system.

Regarding claims 12 and 13, the refrigerant temperature used by Singh et al is the refrigerant temperature at the inlet of the compressor, received from a probe (120, see paragraph [0062]) placed at the inlet of the compressor.

Regarding claim 14, Singh et al explicitly discloses the placement of a probe (114, see paragraph 0062) at the outlet of the compressor for measuring the refrigerant temperature at the outlet of the compressor, and the system of Singh et al is capable of using the temperature at the outlet of the compressor as the refrigerant temperature relative to the compressor.

12. Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Singh et al (US Patent Application Publication No. 2003/0005710) in view of Thermodynamics: an engineering approach (Cengel and Boles, international edition 2004), further in view of Gregg et al (US Patent No. 4,977,529).

Regarding claim 3, it is noted that Singh et al does not explicitly disclose the modeling of the valve flow area as a series of linear functions. However, Gregg et al discloses a valve simulation which estimates valve flow area using a series of linear

functions (see column 148 lines 43-60). It would therefore have been obvious to one of ordinary skill in the art at the time of the invention to implement the modeling technique of Gregg et al in the system of Singh et al as a mathematically simple but effective backup, to ensure the received data did not indicate a system fault.

13. Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Singh et al (US Patent Application Publication No. 2003/0005710) in view of Thermodynamics: an engineering approach (Cengel and Boles, international edition 2004), further in view of Gregg et al (US Patent No. 4,977,529), further in view of Ben Yahia (US Patent Application Publication No. 2003/0159452) and the application.

Regarding claim 4, it is noted that the system of Singh et al in view of Cengel and Boles, further in view of Gregg et al does not explicitly disclose the pressures at the expansion valve to be between approximately 80 bar and 135 bar or the areas to be between approximately .07 mm^2 and 3.14 mm^2. However, the supercritical air conditioning cycle of Ben Yahia uses carbon dioxide (see paragraph [0002]), and it would have been obvious to one of ordinary skill in the art to use pressures between approximately 80 bar and approximately 135 bar when modeling a system using carbon dioxide in order to optimize performance. Additionally, as the general concept of optimizing the dimensions of an expansion valve for a particular application following completion of a design falls within the realm of common knowledge, it would have been obvious to one of ordinary skill in the art at the time of the invention to use the pressures of approximately 80 bar, 110 bar, and 135 bar, and the areas of .07 mm^2, .5 mm^2, .78 mm^2, and 3.14 mm^2 in a model of the expansion valve of Singh et al in view of Cengel

and Boles, further in view of Gregg et al, further in view of Ben Yahia et al, in order to use the best balance of accuracy and simplicity possible.

Conclusion

14. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Duff et al (US Patent No. 5,677,677) discloses a system with all appropriate temperature and sensor probes in an air conditioning system. Liu et al (US Patent Application No. 2004/0060310) discloses an air conditioning system which uses relative pressures to calculate the mass flow rate of the refrigerant and the power consumed by the compressor. Ben Yahia et al (US Patent Application No. 2005/0223740) discloses an expansion device for an air conditioning system. Hamery et al (US Patent No. 6,339,933) discloses an air conditioner with a control unit providing ventilation control according to various refrigerant pressures and temperatures. Ben Yahia (US Patent Application Publication No. 2005/0172652) discloses a motor vehicle air conditioning installation with mass flow rate calculation. Crawford (US Patent No. 1,349,409) discloses a method and apparatus for measuring the capacity of refrigerating plants which comprises calculating the mass flow rate of refrigerant based on temperatures. Renders (US Patent Application No. 2002/0116932) discloses a method of diagnosing an automotive air conditioning system using pressure sensors on either side of the expansion valve. Ito et al (US Patent No. 5,224,354) discloses a refrigerating apparatus with temperature sensors on the evaporator and compressor. And Kuroda et al (US Patent Application Publication No. 2002/0023451) discloses a

vehicle air conditioner with refrigerant flow-amount control of the compressor based on relative pressures, and uses carbon dioxide as a refrigerant.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ALEXIS K. COX whose telephone number is (571)270-5530. The examiner can normally be reached on Monday through Thursday 8:00a.m. to 5:30p.m. EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Cheryl Tyler or Frantz Jules can be reached on 571-272-4834 or 571-272-6681. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/AKC/

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